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Neonatal Transport Team Performance: Raising the Bar

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Current best medical practice recommends high-risk infants be delivered in perinatal centers with intensive care nurseries and neonatal specialists available to provide immediate resuscitation and stabilization. Unfortunately, many high-risk infants are not delivered in perinatal centers because maternal factors restrict ability to transport. In addition, neonatal problems are not always diagnosed before birth. Therefore, the need exists for specialized neonatal transport teams to quickly mobilize to the referring hospital, equipped with necessary supplies and equipment, in order to stabilize and care for the critically ill neonate.

Description of the Problem

Neonatal transport teams combine the complexities associated with stabilization and management of a sick neonate with the dangers inherently associated with moving any patient from one location to another. Transport team members are expected to provide state-of-the art neonatal care in an ever-changing, challenging environment. Changes in environmental temperatures and excess noise and vibration, combined with the extremely limited workspace inside of a medical helicopter, an ambulance, or fixed-wing aircraft, can interfere with the transport team's ability to adequately assess the neonatal patient and intervene appropriately. This uncontrollable environment exposes the neonate to increased risks of adverse events, which may result in significant long-term injury or even death.

One example of an adverse event related to the transport of premature infants is intraventricular hemorrhage (IVH). Transported premature infants have an increased incidence of IVH when compared to premature infants who are not transported (Mohamed, 2010). Transporting a fragile neonate involves extreme challenges that do not exist when transporting adults or even children. Precision in every detail is paramount. The turn of a head or accidental

movement of an endotracheal tube by as much as a centimeter may, in some cases, be detrimental and may adversely affect the long- term physical and/or neurologic outcome. Neonatal transports are high-risk, low-volume health care events; therefore, neonatal transport teams should be carefully structured to minimize the inherent risks as much as possible. According to the 2007 American Academy of Pediatric *Guidelines for Air and Ground Transport of Neonatal and Pediatric Patients,* "The main goals of a neonatal-pediatric transport team are early stabilization and initiation of advanced care at the referring institution, with continuation of critical care therapies and monitoring en route, so as to improve safety of the transport and patient outcome. The patient's condition should not deteriorate owing to preventable issues during transport and, ideally, is improved by arrival at the receiving hospital" (Woodward, 2007, p. 1).

In order to gain an understanding of some of the patient safety concerns of neonatal transport teams, it is necessary to briefly review the history of healthcare safety. Overall health care safety has been a significant concern in the United States since the early 1900's. In 1915, the American College of Surgeons allocated $500.00 to establish standards for quality patient care in hospitals as a result of a study demonstrating dismal outcomes for hospitalized patients. These *Minimum Standards for Hospitals* eventually led to voluntary accreditation for hospitals by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), chartered in 1951 (Woodward, 2007, p. 303). Accreditation by JCAHO is voluntary and most facilities that are surveyed receive accreditation (~99%). JCAHO does not view accreditation as a public regulatory program. Instead, JCAHO identifies itself as a consultant, paid by and responsible to the medical care industry. It acts as a quality control consultant to the hospitals it inspects. Despite the fact that JCAHO considers itself a private consultant, it plays a major role in

government regulatory programs. Although accreditation is in theory voluntary, hospital accreditation is a requirement for participation in many private or public licensing, certification and financing programs. For example, the federal government relies heavily upon JCAHO accreditation for certifying health care facilities for participation in the Medicare program (Jost, 1983).

Neonatal transport medicine is not included in JCAHO accreditation programs. According to a 2003 Air Medical Journal Associates article, JCAHO was approached in 1998 regarding the possibility of including air medical transport in their accreditation process. At that time, JCAHO felt they did not have the background or the experience to develop standards related to aviation and therefore were not interested in developing a JCAHO process for any medical transport program within the United States. Interestingly, JCAHO has operated an *international* medical transport-accrediting program for hospitals since 1999 and in 2003 the first edition of the Joint Commission International Accreditation Standards for Medical Transport Organizations was published (Frazer, 2003).

Two significant issues that contribute to the safety concerns of air medical services are the Airline Deregulation Act (ADA) of 1978 and the change in Medicare reimbursement for air ambulance services that occurred in 2002. The ADA was enacted for the specific purpose of removing government control over fares, routes and market entry for new airlines in the commercial aviation industry. Unfortunately, an unintended consequence of the ADA was the specific prohibition of states' ability to oversee certain aspects of air ambulance services (ACCT, 2011). In addition, unlike other areas of medicine, Medicare does not currently differentiate air ambulances based on quality, capability, or patient safety. Medicare reimbursement of air

ambulances changed in 2002. The change improved Medicare reimbursement to compensate for the high fixed cost of meeting the highest quality and patient safety for patients requiring air ambulance transport. However, Medicare does not require adherence to those higher standards, and pays the exact same base rates to all air ambulance providers. This has produced significant differences in medical capability, patient safety and quality. For those voluntarily meeting the highest capabilities, the Medicare fee schedule barely covers their costs; for others it can be financially lucrative. The Medicare fee schedule has led to an expansion of more than double the number of medical helicopters since 2002. While the growth has potentially expanded access in some areas, the growth has also occurred where medical helicopters were already in abundance. Unfortunately, the ADA prevents states' ability to oversee air ambulance availability, ensure statewide availability of medical helicopters while preventing duplication of services. Since the 2002 Medicare fee schedule adjustment, available air ambulance growth has increased 434%, dedicated air medical helicopter operators have increased 88% but the number of patients transported by air ambulance has only increased 33% (GAO Report, 2010).

With the exception of the Federal Aviation Administration (FAA), which provides safety regulations for the aviation aspect of medical transports, no other state or federal regulations exist to provide structure or oversight for medical transport programs (Frazer, 2010). Those within the medical transport profession recognized the need for improved standardization and regulations related to the transport of patients. The Commission on Accreditation of Air Medical Services (CAAMS) was organized in 1990, in response to the unacceptably large number of air-medical crashes and deaths in the 1980's. Specific standards were developed at that time that addressed safety and patient care issues that formed the foundation for CAAMS accreditation. In 1997 CAAMS expanded to meet the needs of ground critical care transport services and led to

the name change to Commission on Accreditation of Medical Transport Systems (CAMTS). CAMTS currently sets general national safety and patient care standards for all modes of transport.

CAMTS accreditation is voluntary and indicates a commitment to quality patient care and a safe environment for transport team personnel. Reimbursement is not structured to acknowledge CAMTS accreditation. As of October 2010, 156 medical transport programs were CAMTS certified (CAMTS, 2011).

Medical transport teams are either hospital based or community based programs. Hospital based teams are usually operated by the hospital system and transport team members are hospital employees. Hospital-based teams tend to support dedicated transport teams with full time specialty medical personnel (neonatal and pediatric specialists) available to transport high-risk neonates or high-risk pediatric patients. As a general rule, these team members train together and work together on a regular basis. The regularity with which they work together affords them the opportunity to mature as a team and achieve and maintain a level of competency required for safe neonatal transports.

Community-based transport companies provide transport services within a particular geographical region and transport patients for several different hospitals, as well as providing pre-hospital emergency services. Community-based transport programs utilize a combination of emergency medical technicians, paramedics and registered nurses, certified in advanced cardiac life support (ACLS) and advanced trauma life support (ATLS). These programs are adult-oriented with limited ability to independently and safely transport neonatal patients. When community-based transport programs are utilized for neonatal transports, neonatal specialists from the receiving hospital frequently augment the transport team. These specialty team

members include two or three neonatal specialists (neonatal fellows, neonatal nurse practitioners, neonatal registered nurses, or neonatal-trained respiratory therapists). These specialty teams are considered non-dedicated teams in that they do not work together in the transport environment on a regular basis. The ad-hoc nature of this team configuration challenges the specialty team members to function safely and effectively within the "part-time" neonatal transport team model.

Literature Review

The literature was searched for information about neonatal transport teams, team training strategies, team performance, and aviation training concepts related to medicine. An electronic search of CINAHL, and MEDLINE databases was performed using keywords and key phrases health care teams, team training, team performance, crew resource management, human error in health care, neonatal transports, and health care safety. With the exception of the 1999 landmark report from the Institute of Medicine, *To Err is Human: Building A Safer Health System,* only literature published within that past 10 years was included. In addition, relevant references cited in reviewed articles were retrieved.

The 1999 Institute of Medicine's (IOM) landmark report *To Err is Human: Building a Safer Health System* concluded that up to 98,000 patient deaths occurred annually from preventable, care-related errors. According to the report, preventable medical errors in hospitals exceed death rates of motor vehicle accidents, breast cancer, and AIDS. In addition to the cost to human life, preventable medical errors result in total cost of between $17 billion and $29 billion per year in hospitals nationwide (including the expense of additional care required as a result of the errors, lost income and household productivity, and disability). Medial errors also damage societal trust in the health care system (Kohn, et al, 2000).

The IOM report defines "safety as freedom from accidental injury. Error is defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim" (Kohn, et al, 2000, p. 4). The IOM report blames the decentralized and fragmented nature of the healthcare delivery system for contributing to unsafe conditions for patients. The goal of the IOM report was to break the cycle of inaction. The report suggested a comprehensive approach to improving patient safety (Kohn, et al, 2000).

In the IOM's report the committee presented a comprehensive strategy, by which government, health care providers, industry, and consumers could reduce preventable medical errors. The IOM recommended "a four-tired approach:

1. Establishing a national focus to create leadership, research, tools and protocols to enhance the knowledge base about safety;

2. Identifying and learning from errors through immediate and strong mandatory reporting efforts…[and encouraging]….voluntary efforts, both with the aim of making sure the system continues to be made safer for patients;

3. Raising standards and expectations for improvements in safety through the actions of oversight organizations, group purchasers, and professional groups; and

4. Creating safety systems inside [healthcare] organizations through the implementation of safe practices at the delivery level. This level is the ultimate target of all the recommendations" (Kohn et al., 2000, p.6).

The IOM noted that the majority of medical errors result from *system* failures, rather than from individual providers' substandard performance. Therefore, the IOM recommended establishing interdisciplinary team-training programs. The IOM' s stated goal was to reduce the rate of medical errors by 50 percent over a five-year period (Kohn, et al, 2000).

A follow-up article was published in 2004, titled *Five Years After To Err Is Human: What have we learned?* Written by Drs. Lucian Leape and Donald Berwick and published by the Journal of the American Medical Association, the article presents a harsh assessment of the health care system's performance five years after the original IOM report was published. All hospitals implemented new practices to improve safety. But in spite of the fact that newly-implemented safety efforts appeared to improve safety in very specific situations, their overall impact was difficult to see in national statistics because no comprehensive nationwide monitoring system had been established and implemented (Leape, 2005).

According to the article, although patient safety improvements were difficult to identify, the impact on attitudes within health care organizations was profound. Healthcare leaders learned a great deal about safety during those five years. The effects of the IOM report were evident in three areas: viewing the task of error prevention, enlisting the support of stakeholders, and changing practices. In the mid 1990's almost no one was talking about patient safety. In 1999, prior to the IOM report, a few hospitals were developing a strong commitment to patient safety. By 2005, most health care institutions were involved in patient safety improvements to some extent and public awareness was at an all-time high. However, in spite of the increased focus on patient safety initiatives health care was not measurably safer. The article blames three aspects of the culture of medicine for the lack of improvements: 1) the culture of medicine is deeply rooted, both by custom and by training, in high standards of autonomous individual performance, as opposed to team performance, 2) the vast complexity of the health care system in terms of relationships and the large number of specialists, subspecialists, and allied professionals interacting with each other and, 3) apathy toward attempts by others outside the profession to improve practice and skepticism of the concept that systems failures are the underlying cause of

most human errors. In addition, a fear of malpractice liability inhibits willingness to discuss, or even admit errors. Creating cultures of safety requires major changes in behavior, changes that professionals easily perceive as threats to their authority and autonomy. (Leape, 2005).

According to the article, "neither strong evidence of ongoing serious harm nor the activities, examples, and progress of a courageous minority are sufficient to generate the national commitment needed to rapidly advance patient safety. Such a commitment is not likely to be forthcoming without more sustained and powerful pressure on the hospital boards and leaders—pressure that must come from outside the health industry" (Leape, 2005, p. 2389).

The article also suggests safety efforts must be aligned behind common national safety goals that are strict, ambitious, quantitative and well tracked. According to the article, "The most important lesson of the past 5 years since the IOM spoke out on one of the major public health issues of our time is that we will not become safe until we choose to become safe (Leape, 2005, p. 2390).

Effectiveness of team training was demonstrated in two meta-analyses conducted by Salas. et al (2007) (2008). In the first study, *Testing Three Team Training Strategies in Intact Teams: A Meta-Analysis*, Salas et al, examined three specific team-training strategies used by intact teams:

1) "Team Coordination and Adaptation Training: refers to a team training intervention in which team members are trained to alter their coordination strategy and to reduce the amount of communication necessary for successful task performance. Team coordination and adaptation training are assumed to help team members learn about specific teamwork skills and how to optimize the value of idle periods when task demands are low by anticipating and discussing potential problems.

2) Guided Team Self-Correction Training: refers to a team training intervention in which team members learn to diagnose the team's problems and to develop effective solutions. Guided team self-correction training is assumed to foster correct

expectations (i.e., shared mental models) among team members, thereby contributing to more effective team performance).

3) Cross Training: refers to a team training intervention in which team members rotate positions during training to develop an understanding of the knowledge and skills necessary to successfully perform the tasks of other team members. Cross training is assumed to give team members an overall framework for understanding the team's task and how each individual's role is important to it" (Salas, et al., 2007, p. 474-475).

Their results indicated that overall team training strategies did improve team performance. The analysis indicated that Team Coordination and Adaptation Training, a form of team training similar to Crew Resource Management (CRM) training, accounted for 37% of the variance in team performance. Similarly, Guided Team Self-Correction training accounted for 20% of the variance in team performance. Cross training, the third strategy examined, did not result in an effect on performance. However, according to Salas, et al, more recent work has re-examined the effect of cross training and has found that it accounts for 15% of the variance in performance.

In 2008 Salas and colleagues published another meta-analysis, *Does Team Training Improve Team Performance?* This meta-analysis focused on both task work and teamwork. It treated each form of team training as equivalent and treated all targeted outcomes of team training interventions as interchangeable. Their findings indicated that overall team training had a positive effect on team functioning ($p = 0.34$). The relative effectiveness of specific interventions on team cognitive, affective, process, and performance outcomes was assessed. Training content, team membership stability, and team size were investigated as potential moderators of the relationship between team training and outcomes. The database consisted of 93 effect sizes representing 2,650 teams. The results suggested positive relationships exist between team training interventions and each of the outcome types. Their findings suggest team-training interventions are a viable approach organizations can take in order to enhance team outcomes (Salas, 2008).

The final database for the research consisted of a total of 93 correlations obtained from 45 primary studies, representing 2,650 teams (1,660 teams were teams from the lab or classroom setting, 762 teams were from the military sector, 138 teams were aviation teams, 80 teams were medical teams, and 10 teams were from business organizations). Of the 45 studies included in the meta-analytic database, 31 were published and 14 were unpublished. The meta-analytic results for the four primary areas of investigation (cognitive, affective, process, performance) were reported. Key pieces of information from each analysis includes the number of teams in each analysis (N), the number of independent effect sizes (correlations) in each analysis (k), the mean weighted observed correlation (r), and the 80% confidence interval for that correlation. In addition, the tables display the estimated true score correlation (p), the standard deviation of this true score correlation (SD_p), the 80% credibility interval (10% CV and 90% CV), and the percentage of variance accounted for by statistical artifacts (Salas, 2008).

The overall results support the authors' hypothesis that team training does work. Team training was shown to have a moderate, positive effect on team functioning (p = 0.34; 10% CV= 0.34; 90% CV = 0.34). The results revealed team training to have a positive effect on each of the four outcomes under investigation (cognitive, affective, teamwork processes, and performance). The findings suggest team-training interventions are a viable approach for organizations to take in order to enhance team performance and outcomes. In the study, team training accounted for approximately 12% to 19% of the variance in the examined outcomes. The research also showed membership stability moderated the relationship between team training and team outcomes, such that intact teams that underwent training improved the most on process and performance outcomes. The authors suggest intact teams have already overcome some of the

maturational challenges that newly formed teams would not have had the opportunity to navigate (Salas, 2008).

In a 2003 report titled *Medical Teamwork and Patient Safety: The Evidence-Based Relation* prepared for the Agency for Healthcare Research and Quality (AHRQ) by Baker, et al, empirical evidence concerning the relationship between teamwork and patient safety was reviewed. The evidence suggests training teams of health care providers constitutes a practical, effective strategy for enhancing patient safety by reducing medical errors. This report applies Crew Resource Management (CRM) research to the field of medicine. It also provides a comprehensive review and evaluates the effectiveness of current medical team-training initiatives. The report focused on research conducted in other, parallel, high-stress, high-risk environments such as the military and commercial aviation where the consequences of error are extreme. According to the report, the definition of "team" includes the following five characteristics:

1. Teams consist of a minimum of two or more individuals.
2. Team members are assigned specific roles, perform specific tasks, and interact or coordinate to achieve a common goal or outcome.
3. Teams make decisions.
4. Teams have specialized knowledge and skills and often work under conditions of high workload.
5. Teams differ from small groups because teams embody the coordination that results from task interdependency; that is, teamwork characteristically requires team members to adjust to one another, either sequentially or simultaneously, to achieve team goals (Baker, et al, 2003).

Examples of teams that fit this definition include military command-and-control teams, cockpit crews, SWAT teams and fire rescue teams. This definition also fits healthcare teams, such as medical emergency teams, intensive care units, operating room teams, and neonatal transport teams, to name a few.

"The AHRQ review concluded that:

1. The medical field lacks a theoretical model of team performance.
2. The science of team performance and training can help the medical community improve patient safety.
3. Research has already identified many of the competencies that are necessary for effective teamwork in medical environments.
4. A number of proven instructional strategies are available for promoting effective teamwork.
5. Team-training strategies must be further adapted to suit medical needs.
6. The medical community has made considerable progress in designing and implementing team training across a number of settings.
7. The impact of medical CRM training on patient safety outcomes has not been addressed.
8. The institutionalization of medical team training across different medical setting has not been addressed" (Baker, et al, 2003, p. 42-46).

According to the article, the delivery of recurrent team training across the healthcare community is generally haphazard. Few mechanisms exist to ensure that it occurs on a regular basis. Few system-wide procedures exist for reporting errors, and few organizational policies allow and encourage providers to report near misses, without incurring sanctions. As a result, the health care system often fails to regard medical teamwork as an important component of medical performance. One way to correct this systemic indifference is to institute a formal,

mandatory error-reporting system. Another strategy would be to require that providers participate at specified intervals in team-training programs (Baker, et al, 2003).

The authors identify the following five research needs:

1. Develop a theoretical model of medical-team performance.
2. Focus more attention on measuring teamwork processes and outcomes as they relate to medicine.
3. Evaluate medical-team training more effectively.
4. Focus on diagnosing team performance.
5. Determine the role of simulation-based training (Baker, et al, 2003).

The authors acknowledge the significant expense of team training and pose the following two questions, "What constitutes the optimal trade-off between training effectiveness and cost effectiveness?" and " To what degree must an effective simulation reflect physical versus psychological fidelity?" (Baker, et al, 2003, p. 51). Based on previous simulation-training research, the authors assume the more realistic the training scenario, the more effective the training. Essentially, health care teams must *function* as teams during training.

Briget Cross and Diana Wilson, in their 2009 article, *High-Fidelity Simulation for Transport Team Training and Competency Evaluation,* discuss challenges facing training and competency evaluation of transport team members and discuss incorporation of high-fidelity simulation into their neonatal transport team education programs (Cross, 2009, p. 202). In 2004 JCAHO published a Sentinel Event Alert, evaluating 109 perinatal cases, 93 resulting in death and 16 resulting in major permanent disability. Root cause analysis of 47 of the cases found 72% had issues with communication involving hierarchy and intimidation, failure to function as

a team, and failure to follow the proper chain of communication; 47% had issues with staff competence; and 40% had issues related to the lack of orientation and appropriate training.

The authors discuss the fact that simulation-based training has already been adopted as the standard in many highly technical, complex, and dynamic professions. They also explain many national and international health organizations recommend simulation-based medical training. The authors suggested that national standards for neonatal transport team education and certification are needed to promote the highest level of care for critically ill neonates and effectively reduce morbidities and mortality in the neonatal patient population.

Mohamed and Aly, in their 2010 article, *Transport of premature infants is associated with increased risk for intraventricular hemorrhage,* examined the correlation between inter-hospital transports and the incidence and severity of intraventricular hemorrhage (IVH) in VLBW infants. According to the article, IVH significantly impacts long-term outcomes of very low birth weight VLBW infants. IVH's are categorized as Grade I through Grade IV. Grade I is a germinal matrix hemorrhage, is limited to the subependymal area, and does not involve the ventricles. A Grade II IVH occurs within the ventricles but does not cause ventricular distention. A Grade III IVH is severe enough to cause ventricular distention and a Grade IV IVH involves the ventricles and parenchyma. The article defines severe IVH as grade III-IV and non-severe IVH as grades I-II (Mohamed, 2010).

" Almost 60% of severe IVH survivors may develop cerebral palsy, and about 70% will be mentally retarded" (Mohamed, 2010, p. F406). Even though infants with non- severe IVH are not a high risk for severe handicaps, they have lower test scores on the Mental Developmental Index or when their visual-motor integration was assessed. The incidence of IVH in VLBW infants significantly decreased over the past few decades from 40-50% in 1980's to

approximately 20% in 1990. Unfortunately, the incidence of IVH has not improved since 1990. In fact, a significant trend for increased IVH nationwide has emerged since 2003-2004. Such an increase in IVH is associated with a noticeable increase in the use of neonatal transports (Mohamed, 2010).

The datasets produced by the Healthcare Cost and Utilization Project (HCUP) from the AHRQ was utilized for the study. These datasets come from a database collected annually from the hospitalization records of inpatient admissions from more than 1000 hospitals across the United States. HCUP produced the National Inpatient Sample Database (NIS) and its pediatric version (KID). NIS data represent a 10% sample of all hospital admissions during any given years for patients of all ages. KID dataset has similar data elements but only includes pediatric patients. KID dataset is available for the years 1997, 2000 and 2003 and was included in the study. The NIS dataset for the years 1998, 1999, 2001, 2002 and 2004 were also included in the study. Infants < 1500 grams were included and were classified into either inborn or transport groups. Groups were further delineated according to birth weights of < 1000 grams and 1000-1499 grams. IVH and severe IVH (grades 3-4) were compared between groups and subgroups. Infants with missing data for transport status or birth weight were excluded from the study. Infants transported after the first 48 hours were also excluded as intraventricular hemorrhages occurring after 48 hours of age are generally considered as independent of transport. Infants with central nervous system anomalies, congenital heart disease (except patent ductus arteriosus), congenital lung anomalies, congenital abdominal wall defects, multiple congenital anomalies and chromosomal disorders were excluded as they can directly attribute to the occurrence of IVH or affect the outcome of the preterm infants (Mohamed, 2010).

SAS V.8.2 was used to conduct all statistical analyses. X^2 and Fisher exact tests were used to calculate odds ratios (OR) for IVH and severe IVH in the transport group compared to the inborn. Logistic regression models were used to calculate adjusted OR for IVH or severe IVH in transport group compared to the inborn, controlling for several demographic and clinical confounders. Confounding variables included sex, race, extremely low birth weight (ELBW < 1000 grams), birth asphyxia, fetal academia, apnea of prematurity, respiratory distress syndrome (RDS), persistent pulmonary hypertension of the newborn, pneumothorax, pulmonary hemorrhage, PDA, sepsis, necrotizing enterocolitis, maternal hypertension, maternal infection or chorioamnionitis, antepartum hemorrhage, cord prolapse, or nuchal cord, breech presentation, and instrumented delivery. IVH grades three and four were considered to be severe IVH. X^2 Test was used to detect significant trends in the frequency of inter-hospital transport or the incidence of IVH over the years of the study (Mohamed, 2010).

A total of 67,596 infants < 1500 grams met the inclusion and exclusion criteria. 9.2% were transported between hospitals during the first 48 hours of life. The overall incidence of IVH was 14.7%, the overall mortality was 24.5% and 46% of the babies were < 1000 grams at birth. There was no difference between the transport and inborn groups with regards to sex or Caucasian race. The transport group had fewer African Americans, more Hispanics, more ELBW infants and more RDS.

The transport group had more IVH compared to the inborn group (27.4% vs. 13.42%); adjusted OR 1.75 (95% CI 1.64 to 1.86, p <0.001). Of the VLBW infants who had IVH, 41.9% had the diagnostic code of IVH. The diagnosis of severe IVH (grades 3-4) was found in 35.3% of these cases. Severe IVH was higher in the transport when compared to the inborn group (44.1% vs. 32.9% respectively); adjusted OR 1.44 (95% CI 1.22 to 1.70, p<0.001).

For infants <1000 grams, the overall IVH and severe IVH were increased in the transport compared to inborn group; adjusted OR 1.91 (95% CI 1.76 to 2.08, p<0.001) and 1.36 (95% CI 1.12 to 1.66, p = 0.002), respectively. For infants 1000-1499 grams, IVH and severe IVH were higher in transport group as well; adjusted OR 1.47 (95% CI 1.33 to 1.63, p<0.001) and 1.60 (95% CI 1.18 to 2.18, p = 0.003), respectively.

The study demonstrated an increase in both the overall incidence of IVH as well as severe IVH in VLBW infants who are transported to a tertiary center for care vs. infants who are born at the tertiary center. The correlation between IVH and transport remained high after controlling for confounding factors that are known to increase the risk for IVH.

Almost all IVH (98%) occur in the first week of life, the majority of them within the first 48 hours after birth. Low-grade IVH may progress into high grade IVH in the first one or two days after the initial bleed. In this study, only infants transferred within the first 48 hours of life were included to capture only those who might develop IVH in correlation with the transport process. Possible explanations for increased incidence of IVH of transported infants include: 1) vigorous manipulations, 2) kinking or obstruction of the endotracheal tube, and 3) self-extubation or iatrogenic trauma while moving the infant. While the overall incidence of IVH decreased from 40-50% in the 1980's to ~ 20% in the 1990's, there is an alarming trend of an increased incidence in IVH since 2003. Such an increase is associated with a noticeable increase in the use of neonatal transports. The clinical implications of the study are to encourage more regionalization of care and to continue to encourage the transport of high-risk mothers to tertiary care centers. According to the article, regionalization of care has been shown to significantly improve neonatal outcomes (Mohamed, 2010).

IMPACT ON FAMILIES

When an infant requires transport to an intensive care nursery, parents are unprepared for the crisis that inevitably follows. The referring physician makes the decision to transfer the infant, frequently with little or no parental input. Parents and family members are instantly plunged into both an emotional, as well as a potential financial crisis. In an instant, their life changes. They experience fear over their infant's health and safety, fear of separating from family to accompany their infant to another city or state, fear of having adequate financial resources to live away from home for an indefinite period of time, and fear of isolation as they are removed from family, friends, and community. Parents of transported infants need information and support.

In a 2002 article by Steeper, when parents were interviewed about the transport of their critically ill infant, they described it as a negative experience. When an infant is born with a life-threatening condition, parents are expected to cope with the overwhelming information regarding their infant's illness and, simultaneously, they must adjust to the news that their infant will be transported to another city or state. When asked about specifics of the transport experience, parents stressed the overwhelming nature of the experience. They expressed concern related to too much information being presented at a time when they were emotionally unable to process and understand most of what was being presented. Parents requested information be streamlined and limited to only the most important information.

The infant's differential diagnosis should be discussed with the parents as well as information about treatment and prognosis of each of the differential diagnoses. In addition, any anticipated procedures should be explained. All anticipated care of the infant prior to transport, during transport, and upon arrival at the receiving hospital, should be carefully explained to the parents as well. The parents should be encouraged to ask questions prior to transport.

Parents expressed a desire to receive a pamphlet with information about the NICU, including the phone number. Other information parents deemed as "important" included directions to the referral hospital, parking information, and hotel/restaurant options. Parents also expressed the value of having their infant brought to mom's room prior to transport in order for them to see, touch and get pictures. Mothers also stressed the importance of receiving information about pumping/storing breast milk (Steeper, 2002).

RECOMMENDATIONS

A neonatal transport program must be tailored to the specific needs of the neonatal population and only qualified personnel with appropriate training and equipment should perform inter-facility transport of neonatal patients. A neonatal transport program should be designed and developed with a clear mission of safety and expert neonatal care as the ultimate priority. Attention should be focused on transport team design, selection of individual transport team members, team training techniques, program quality initiatives and data collection and analysis. Only health care institutions prepared to support a safe, expert neonatal transport team should consider offering neonatal transport services to its referral base. If hospital administrators conclude the cost of a dedicated, professional neonatal transport team is prohibitive, they should consider contracting neonatal transport services to a proven neonatal transport team provider on a fee-for-service basis.

TRANSPORT TEAM DESIGN

"Every system is perfectly designed to achieve exactly the results it achieves" (author unknown). The American Academy of Pediatrics (AAP), in its 2007 *Guidelines for Air and Ground Transport of Neonatal and Pediatric Patients,* provides information, education, and

guidelines for health care professionals who provide and/or supervise inter-facility transport of children and neonates. Even though the AAP does not provide any regulatory oversight to the neonatal transport community, it does offer neonatal-specific transport guidelines. According to the AAP guidelines, most large transport services have certain organizational features in common. The most important feature is a dedicated team of health care professionals proficient at providing neonatal critical care during transport. The AAP guidelines also emphasize the need for a sufficient number of neonatal transports to enable team members to maintain their skills and to permit staff to be optimally utilized. "Other key components include the following: 1) online (real-time) medical control by qualified medical physicians, 2) ground and/or air ambulance capabilities, 3) communications and dispatch capability, 4) prospectively written clinical and operational guidelines, 5) a comprehensive database allowing for quality and performance improvements activities, and 6) medical and nursing direction, 7) administrative resources, and 8) institutional endorsement and support" (Woodward, 2007, p. 2-3).

"Construction of a well-functioning transport program begins with building a strong foundation, including personnel, training, equipment, communication, and vehicles (ambulance, helicopter, or fixed-wing aircraft). How each of these cornerstones is designed and structured determines the caliber of service. Continual monitoring and evaluation of the transport program are critical to providing quality patient care and ensuring that the program can stand the test of time" (Woodward, 2007, p. 133).

TRANSPORT TEAM MEMBER SELECTION

Providing neonatal critical care during a transport is significantly different from providing care in a neonatal intensive care unit. A neonatal provider, competent within the

confines of the intensive care nursery, may or may not be able to provide competent, safe neonatal care in the patient compartment of an ambulance or helicopter, or in an unfamiliar hospital's NICU or obstetrical operating room. A neonatal transport team member's professional degree is less important than his/her ability to provide the level of neonatal care required in a mobile environment (Woodward, 2007).

Neonatal transport team candidates should be willing participants who choose to apply for a position on the transport team, as opposed to being assigned to the team. Neonatal transport team candidates should possess neonatal experience and expertise. In addition, they should possess a keen ability to troubleshoot and solve problems quickly and creatively. Neonatal transport team candidates should also possess excellent interpersonal and communication skills. Reluctant neonatal transport team members are suboptimal candidates and should never be utilized for such critical medical missions.

TEAM TRAINING

"Teamwork is a set of interrelated behaviors, cognitions, and attitudes. It is more than knowledge and skills. Teamwork depends on the ability of each team member to 1) anticipate the needs of others, 2) adjust to each other's actions and to the changing environment, and 3) have shared understanding of how a procedure should happen in order to identify when errors are occurring and how to correct for these errors" (Salas, 2003, p. 7).

Health care education focuses on individual knowledge, competence, and technical expertise as opposed to teamwork proficiency. Individual health care professionals are expected to function regularly as a member of a health care team, yet most do not ever train together as teams. The current expectation is that a group of healthcare experts is the same as an expert

health care team. This is a “flawed” principle with dangerous implications for all healthcare recipients. According to Baker, et al, system failures cause far more errors than poor individual performance (Baker, 2003).

Suboptimal medical care of a neonatal patient may result in long-term neurologic, as well as physical disabilities or even death. The safety bar must be set at the highest possible level related to the transport of this fragile patient population. Information learned from the team training literature should be applied to neonatal transport team-training programs. Aviation standards and Crew Resource Management principles should also be applied. Errors and even near misses should be considered unacceptable under any circumstances and transport team training should incorporate performance expectations/strategies that reflect a zero tolerance for error.

The transport curriculum should include didactic and practical instruction in the clinical and operational aspects of transport medicine. The transport-training course should be robust and challenging, as should the post-training evaluation process. A written exam and a simulation-style scenario-based training session should be a standard part of a neonatal transport team evaluation process. At the end of the training program, only candidates successfully completing the pre-determined set of written and simulation-based objectives, should be considered for the transport team. The training program should be developed by a small group of neonatal transport experts, education specialists, and simulation specialists. The training program should be evaluated on an annual basis and modified as needed.

Efforts should be made to minimize transport team member turnover as much as possible. As Salas, et al demonstrated in his 2008 meta-analysis, research indicates that team membership stability improved the relationship between team training and team outcomes, such

that intact teams that underwent training improved the most on process and performance outcomes. The authors suggest that intact teams have already overcome some of the maturational challenges that newly formed teams would not have had the opportunity to navigate (Salas, 2008).

The public relations role of the neonatal transport team should also be incorporated in the transport team training process. The transport team is a frontline service provider. The receiving hospital's reputation is on the line every time a neonatal transport team is deployed. The performance of the team reflects the receiving hospital's commitment to overall quality of patient care. Well-orchestrated, professional neonatal transport teams reflect the receiving hospital's commitment to excellence in safety and patient care quality.

QUALITY INITIATIVES

Quality improvement initiatives involve all aspects of the neonatal transport program. "Consumers and the health care industry mandate adherence to particular standards during the provision of patient care. Transport programs should analyze every component of the services provided to ensure effective, consistent, safe, and state-of-the-art care" (Woodward, 2007, p. 134).

The quality improvement process should be integrated into every level of the neonatal transport program. Essential components of the quality improvement program include: 1) a focus on the neonatal patient and family, 2) collaborative efforts for the purpose of improving processes and outcomes of neonatal transports, 3) strong leadership at all levels, 4) strategic planning goals, education and training program, and program development, 5) Data and information that are reliable, rapidly accessible, standardized, and timely 6) neonatal clinical

guidelines and performance measures, 7) commitment to research that contributes evidence for change in practice (Woodward, 2007).

Specific objectives of a neonatal transport team quality improvement initiative (QI) include: 1) identify important characteristics of neonatal transport, 2) Develop and maintain multidisciplinary communication links through the QI process, and provide a forum to present needs and areas for improvement via regularly scheduled meetings, 3) Establish regular review of patient care guidelines and how they are applied to predetermined indicators and other criteria to permit objective monitoring of the key aspects of care, 4) respond in a systematic manner to sentinel, serious, adverse, and near-miss events. Expectations under JCAHO standards for an organization's response to a sentinel event includes a root cause analysis and an action plan (Woodward, 2007).

DATA COLLECTION AND EVALUATION

"The culture of medicine attributes errors to carelessness or incompetence. Liability concerns discourage the surfacing of errors and communication about how to correct them. The lack of explicit and consistent standards for patient safety creates gaps in licensing and accreditation and allows health care organizations to function without some of the basic safety systems in place. The lack of any agency or organization with primary responsibility for patient safety prevents the dissemination of any cohesive message about patient safety" (IOM, 2000, pp 21-22).

"Benchmarking is the process of comparing one's performance with that of others and begins with standardized, comparative measurements and then examines performance differences between similar processes. When applied to transport, benchmarking is the process of setting operating goals by selecting the top performers within the transport industry and

identifying best practices for the performance of the transport service" (Woodward, 2007, p. 134).

The Institute of Medicine, CAMTS and the AAP all stress the value of data collection for the purpose of tracking, measuring, evaluating, and applying lessons learned to improve overall quality of health care. Unfortunately, no organized national data collection process exists for tracking safety and efficacy of neonatal transports. Without a national neonatal transport database, teams are unable to effectively evaluate the safety and effectiveness of their performance or compare it to other transport teams around the country.

The American Academy of Pediatrics, Section on Transport Medicine, has certain criterion they suggest are monitored regularly. These include call time, departure time, response time, referring hospital, receiving hospital, presence of the referral MD at the referral hospital, demographics, data of birth, birth weight/transport weight and primary diagnosis and outcome. Also included are any unexpected events such as: extubation, hypothermia, hypoglycemia, hypoxia, hypotension, resuscitation efforts, and equipment failure. (Woodward, 2007).
A national database for collecting/analyzing neonatal transport data is needed in order to systematically improve the overall quality of care and safety of transported neonatal patients.

CONCLUSION

Inter-facility neonatal transports are inherently risky for both the patient as well as members of the medical transport team. In order to minimize risks, efforts should be made to minimize the need for neonatal transports. When possible, high-risk infants should be delivered at tertiary care centers with neonatal intensive care units. When high-risk infants must be transported, care must be taken to minimize risks to the neonate and the medical team.

Hospitals, committed to providing neonatal transport services to their referral hospitals should be philosophically and financially prepared to support a dedicated, professional neonatal transport team. The primary consideration when configuring a neonatal transport team must be the safety of the neonatal patient and the members of the transporting team. Neonatal transport teams should be carefully designed and developed, incorporating evidence-based team training strategies. Crew Resource Management principles should be applied and simulation training should be incorporated into the training program. On-going quality improvement initiatives should be incorporated into the program. A national data registry needs to be created for the purpose of evaluating quality and safety aspects of neonatal transport team programs around the country. The American Academy of Pediatrics should be encouraged to publish a consensus statement regarding neonatal transport team safety, team configuration standards, transport equipment standards, and performance standards.

With the current financial crisis of the health care industry, hospital administrators are constantly forced to make difficult decisions. However, with regard to neonatal transport teams, only two acceptable options exist: 1) support a professional, dedicated neonatal transport team, or 2) contract with another health care institution, capable of providing a safe neonatal transport team. The gold-standard question any health care administrator should ask themselves when faced with the temptation to endorse a suboptimal neonatal transport program is “Is this transport team safe enough to transport my own child/grandchild?”

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